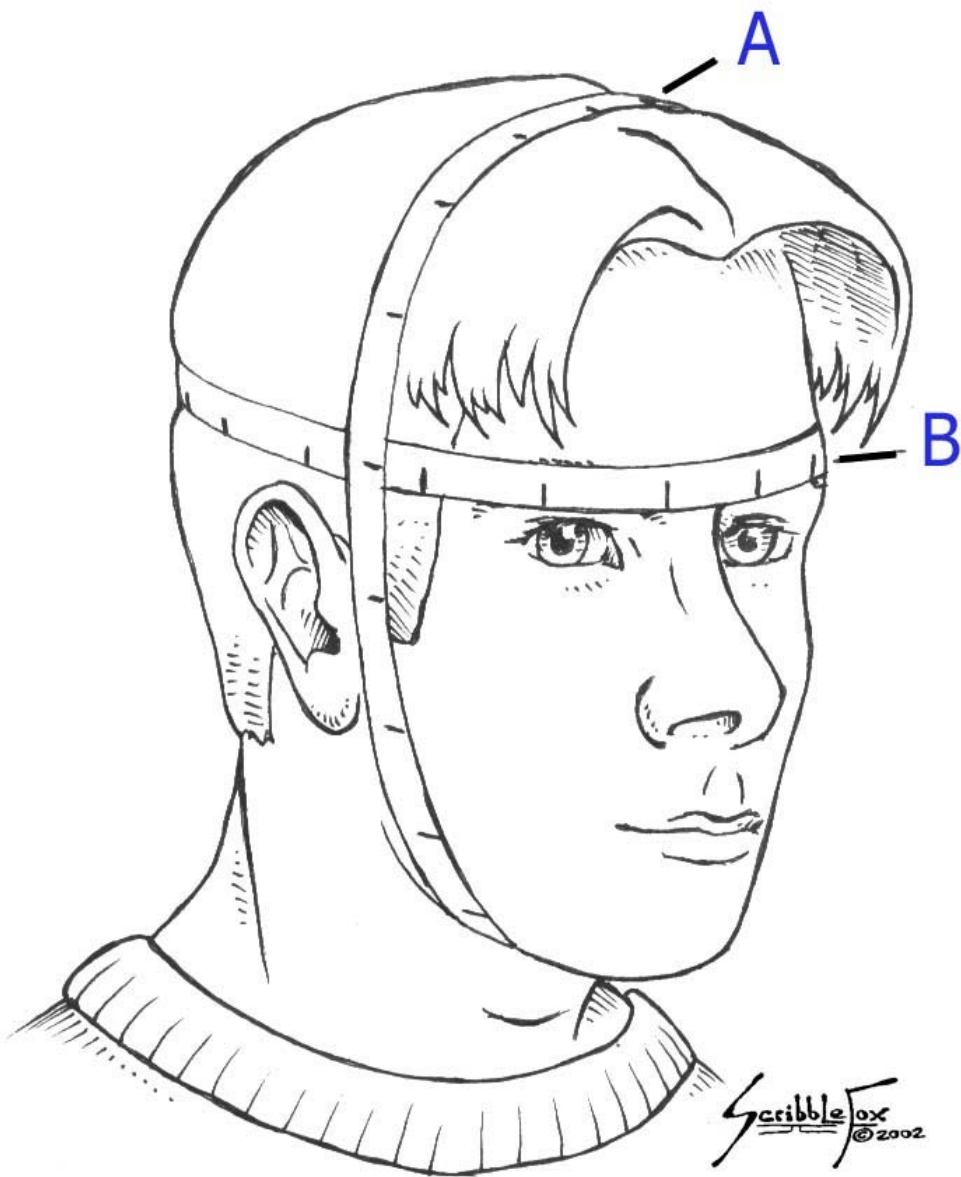# Measurement
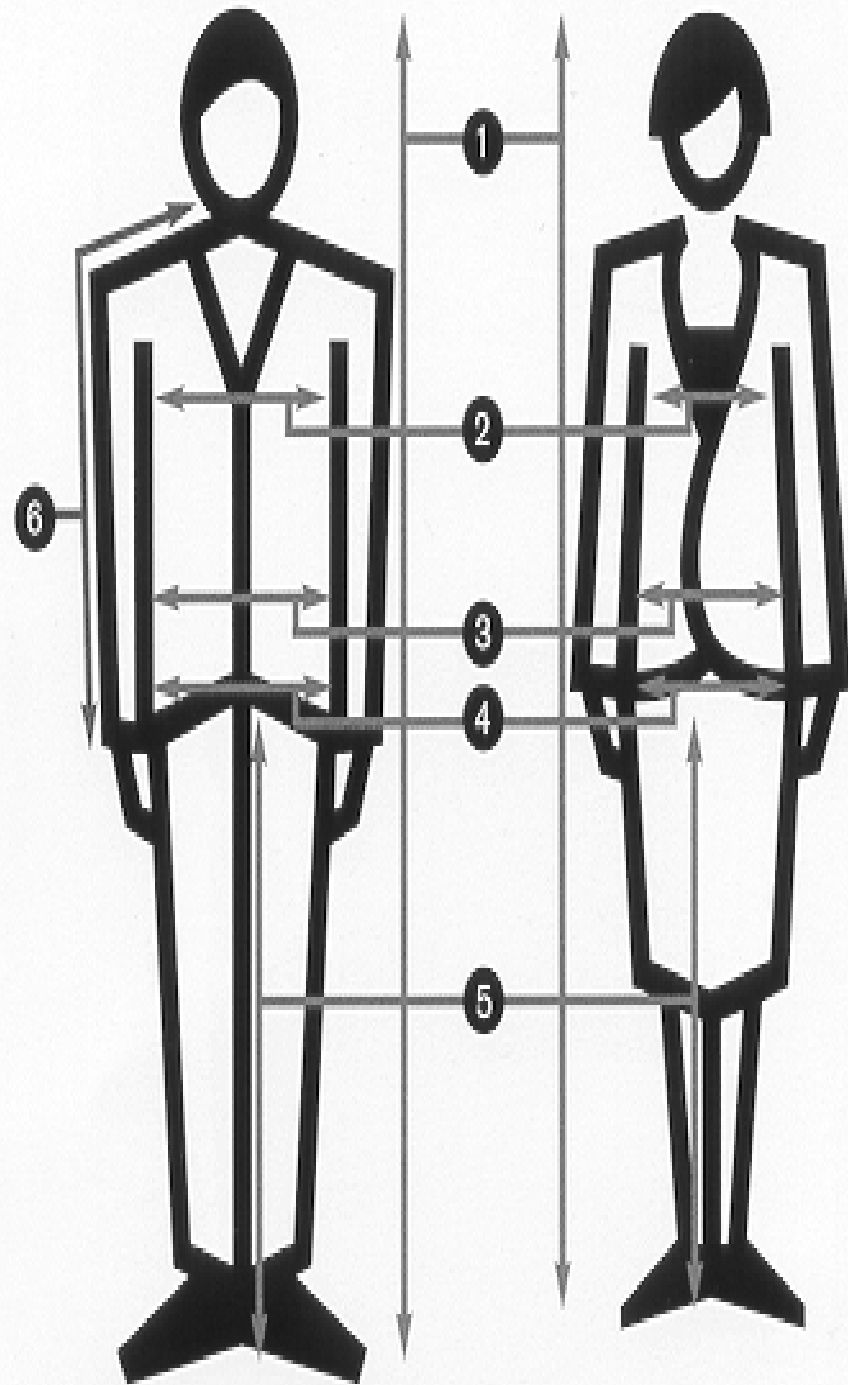
Danil Hammoudi. MD

A - Vertical circumference
B - Horizontal circumference

Measurement is the estimation or determination of extent, dimension or capacity, usually in relation to some standard or unit of measurement. The measurement is expressed as a number of units of the standard (a real number times a unit), such as distance being indicated by a number of miles or kilometers.

The process of measuring involves estimating the ratio of the magnitude of a quantity to the magnitude of a unit of the same type (e.g. length, time, mass, etc.).

A measurement is the result of such a process, expressed as the product of a real number and a unit, where the real number is the estimated ratio. An example is 9 metres, which is an estimate of an object's length relative to a unit of length, the metre.

Unlike a count, or integer quantity of items that is known exactly, every measurement is an estimate that has some uncertainty.

A measurement is a comparison to a standard. -- **William Shockley**

By number we understand not so much a multitude of Unities, as the abstracted Ratio of any Quantity to another Quantity of the same kind, which we take for Unity. -- **Sir Isaac Newton (1728)**

Metric Units

Kilom	Hectom	Decada	m	Decid	Centim	Millim			micron

- 1 kilometer (km) is equal to 1,000 meters 1 km = 1,000 m

- 1 centimeter (cm) is equal to 1/100 meters 1 cm = 0.01 m

- 1 millimeter (mm) is equal to 1/1,000 meters 1 mm = 0.001 m

- 1 micrometer (:m) is equal to 1/1,000,000 meters 1 :m = 0.000001 m

Microu0.000001Millionth
Nanon0.000000001Billionth
Picop0.000000000001Trillionth

Converting Metric Units

The metric system has prefix modifiers that are multiples of 10.

- A kilometer is 1000 meters
- A hectometer is 100 meters
- A decameter is 10 meters
- A meter is the basic unit of length
- A decimeter is 1/10 meter
- A centimeter is 1/100 meter
- A millimeter is 1/1000 meter

As we move down the units, the next unit is one tenth as long. As we move upward, each unit is 10 times as long. One hundred millimeters, which is 1/10 meter (100/1000=1/10) are larger than one centimeter (1/100th meter).

Converting between Metric Units of Mass

Kilog	Hectog	Decada	g	Decig	Centig	Millig			microg
			1						

- 1 kilogram (kg) is equal to 1,000 grams 1 kg = 1,000 g
- 1 milligram (mg) is equal to 1/1,000 grams 1 mg = 0.001 g
- 1 microgram (:g) is equal to 1/1,000,000 grams 1 :g = 0.000001 g

Prefix	Symbol	Factor Number	Factor Word
Tera	T	1,000,000,000,000	Trillion
Giga	G	1,000,000,000	Billion
Mega	M	1,000,000	Million
Kilo	k	1,000	Thousand
Hecto	h	100	Hundred
Deca	da	10	Ten
Deci	d	0.1	Tenth
Centi	c	0.01	Hundredth
Milli	m	0.001	Thousandth
Micro	u	0.000001	Millionth
Nano	n	0.000000001	Billionth
Pico	p	0.000000000001	Trillionth

Converting between Metric Units of Mass
The metric system has prefix modifiers that are multiples of 10.
- A kilogram is 1000 grams
- A hectogram is 100 grams
- A decagram is 10 grams
- A gram is the stem unit of mass
- A decigram is 1/10 gram
- A centigram is 1/100 gram
- A milligram is 1/1000 gram

Converting Metric Volume Units

The metric system has prefix modifiers that are multiples of 10.

- A kiloliter is 1000 liters
- A hectoliter is 100 liters
- A decaliter is 10 liters
- A liter is the basic unit of volume
- A deciliter is 1/10 liter
- A centiliter is 1/100 liter
- A milliliter is 1/1000 liter

As we move down the units, the next unit is one tenth as large. As we move upward, each unit is 10 times as large. One hundred milliliters, which is 1/10 liter (100/1000=1/10) are larger than one centiliter (1/100th liter).

Volume

Kilol	Hectol	Decal	L	Decil	Centil	Millil			micron

1 milliliter (ml) is equal to 1/1,000 liters 1 ml = 0.001 l

1 microliter (:l) is equal to 1/1,000,000 liters 1 :l = 0.000001 l

- **A kiloliter is 1000 liters**
- **A hectoliter is 100 liters**
- **A decaliter is 10 liters**
- **A liter is the basic unit of volume**
- **A deciliter is 1/10 liter**
- **A centiliter is 1/100 liter**
- **A milliliter is 1/1000 liter**

U.S. Length Measurements

The smaller U.S. standard basic units of length are the inch, foot and yard.

A foot is twelve inches and a yard is 3 feet or 36 inches.

Many measurements are made that are less than one inch and for these the U.S. system of measurement uses fractions of an inch (1/2, 1/4, 1/8, 1/16 etc.)

There are other units for measuring small lengths but they are used only in specialized areas (mils, points, picas etc.)

1 inch = 2.54 cm

1 lb = 454 g

1 kg = 2.2 lb

1 l = 1.05 qt

U.S. Length Measurements

This lesson covers some of the larger U.S. length units including:

- foot
- yard=3 feet
- eighth mile = 220 yards = 660 feet
- quarter mile = 440 yards = 1320 feet
- half mile = 880 yards = 2640 feet
- mile = 1760 yards = 5280 feet

There are other length units such as rods, chains, leagues, nautical miles, hands, etc. but they are used only for specialized areas or measurements.

Approximate Conversions between Metric and US Length Units

There are a number of approximate conversions between metric and US length units.

These include:

- A meter is about the same length as a yard
- A meter is about three feet long
- A decimeter is about four inches long
- An inch is about 25 millimeters
- A foot contains about 30 centimeters
- A foot contains about 3 decimeters

U.S. Volume Units

The common measures of volume in the U.S. system of measurements are:
- teaspoons
- tablespoons = 3 teaspoons
- fluid ounces = 2 tablespoons, 6 teaspoons
- cups = 8 fluid ounces, 16 tablespoons
- pints = 2 cups, 16 fluid ounces
- quarts = 2 pints, 4 cups
- gallons = 4 quarts, 8 pints, 16 cups

Temperature Conversion from Celsius to Fahrenheit

The metric system uses the Celsius scale to measure temperature. However, temperatures are still measured on the Fahrenheit scale in the U.S.

Water freezes at 0° Celsius and boils at 100° Celsius which is a difference of 100°. Water freezes at 32° Fahrenheit and boils at 212° Fahrenheit which is a difference of 180°. Therefore each degree on the Celsius scale is equal to 180/100 or 9/5 degrees on the Fahrenheit scale.

How to convert Celsius temperatures to Fahrenheit
- Multiply the Celsius temperature by 9/5.
- Add 32° to adjust for the offset in the Fahrenheit scale.
- Example: convert 37° C to Fahrenheit.

37 * 9/5 = 333/5 = 66.6

66.6 + 32 = 98.6^o F

There is a mental math method to convert from Celsius to Fahrenheit. The ratio of 9/5 is equal to 1.8 and 1.8 is equivalent to 2 - 0.2

How to convert Celsius temperatures to Fahrenheit with mental math.

- Double the Celsius temperature (multiply by 2).

- Take 1/10 of this number (2 * 1/10 = 0.2) and subtract it from the number above.

- Add 32° to adjust for the offset in the Fahrenheit scale.

- Example: convert 37° C to Fahrenheit.
37 * 2 = 74
74 * 1/10 = 7.4
74 - 7.4 = 66.6
66.6 + 32 = 98.6° F

Temperature Conversion from Fahrenheit to Celsius

The metric system uses the Celsius scale to measure temperature. However, temperatures are still measured on the Fahrenheit scale in the U.S.

Water freezes at 0° Celsius and boils at 100° Celsius which is a difference of 100°. Water freezes at 32° Fahrenheit and boils at 212° Fahrenheit which is a difference of 180°. Therefore each degree on the Fahrenheit scale is equal to 100/180 or 5/9 degrees on the Celsius scale.

How to convert Fahrenheit temperatures to Celsius
- Subtract 32° to adjust for the offset in the Fahrenheit scale.
- Multiply the result by 5/9.
- Example: convert 98.6^o Fahrenheit to Celsius.

98.6 - 32 = 66.6

66.6 * 5/9 = 333/9 = 37° C.

There is a mental math method to approximate the Fahrenheit to Celsius conversion. The ratio of 5/9 is approximately equal to 0.55555....

How to approximate the conversion of Fahrenheit temperatures to Celsius with mental math.
- Subtract 32º to adjust for the offset in the Fahrenheit scale.
- Divide the Celsius temperature by 2 (multiply by 0.5).
- Take 1/10 of this number (0.5 * 1/10 = 0.05) and add it from the number above.
- Example: convert 98.6º F to Celsius.
98.6 - 32 = 66.6
66.6 * 1/2 = 33.3
33.3 * 1/10 = 3.3
33.3 + 3.3 = 36.6 which is an approximation of the Celsius temperature

The **International unit**
(**IU**, alternatively abbreviated **UI**, from French *unité internationale*)

 In pharmacology, is a unit of measurement for the amount of a substance, based on measured biological activity (or effect).

It is used for vitamins, hormones, some drugs, vaccines, blood products and similar biologically active substances.

Despite its name, the IU is not part of the International System of Units used in physics and chemistry.

The mass equivalents of 1 IU for selected substances:

- 1 IU Insulin: the biological equivalent of about 45.5 µg pure crystalline insulin (1/22 mg exactly)
- 1 IU Vitamin A: the biological equivalent of 0.3 µg retinol, or of 0.6 µg beta-carotene
- 1 IU Vitamin C: 50 µg ascorbic acid
- 1 IU Vitamin D: the biological equivalent of 0.025 µg cholecalciferol/ergocalciferol (1/40 µg exactly)
- 1 IU Vitamin E: the biological equivalent of about 0.667 mg d-alpha-tocopherol (2/3 mg exactly), or of 1 mg of dl-alpha-tocopherol acetate